

A
DISCOURSE
Concerning
TIME,

With Application of
The *Natural Day*, and *Lunar Month*,
and *Solar Year*, as *Natural*;

And of such as are derived from them,
As *Artificial Parts of Time*, for
Measures in Civil and Common Use:

For the better understanding of
The *Julian Year* and *Calendar*.

THE
First Column also in our *Church-Calendar*
explained.

With other *Incidental Remarks*.

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THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY

JOHN BURNET

OF

GLASGOW

IN TWO VOLUMES

LONDON

THE PREFACE.

THE Reader is not to expect here an Elaborate, Methodical, or Just Treatise, for the entertainment of the Learned; but will find a Collection of several Memoirs, such as may be all of considerable use to those who are not Proficients in this kind of Knowledge.

The Author, having casually discoursed on the ensuing Heads, to one or two Ingenious young Gentlemen; and for their bet-

The Preface.

ter Comprehension, and Remembrance, put many of them dispersedly in Writing: He has now revised those Papers, and enlarged them; Digressing sometimes, and taking in some Astronomical, Chronological, and other Remarks, very worthy and equally needfull to be known, though not so directly pertinent, or necessary to the Explication of the Julian Year, and Ecclesiastick Calendar; which was his chief Intention, but yet giving some light unto them.

He hath since been prevailed with to let them be published, as being thought profitable for the use of Younger Students, whereby to possess them with
some

The Preface.

Some usefull Notions ; such as may prepare and induce them, with more Pleasure and Ease, to advance into the Study of deeper and larger Contemplations of this kind.

*And for the use also of such as have not considered these things, but are content (for want of easie Introduction) to be ignorant, and careless, of this so necessary Knowledge (of whom there are too many to be found, the more the Pity :) That they (if they please) may see the Grounds of our **Calendar**, and Measures of **Time** ; and know the Reason of the Differences between the **Reformed Calendar**, and our old **Julian**,*

The Preface.

lian, in respect of Accounts of the Progress of the whole Year, and of the Moveable Feasts, &c.

'Tis hoped also, This plain Discourse may be usefull to many of our Clergy, whom it concerns to have some knowledge of these Matters.

CON-

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A DISCOURSE

Concerning
TIME, &c.

CH A P. I.

Of Measure in General. § More particularly of Time; and Difficulties concerning it.

GOD made all things in Number, Weight, and Measure; and gave them to be considered by us according to these Properties, which are inherent in Created Beings. But without an Act of the Rational Soul, comparing these, in their several kinds, one to another; they would be as nothing. And there-

fore the ancient Greeks very fitly termed the Habitude of any one of these to another of the same kind, $\Lambda\beta\gamma\delta$, the *Ratio* of it, because it is our Rational Notion of their Equality, or Difference, when we apply one Number, or Weight, or Measure to another of the same kind, and consider, and compute, what Proportion one bears to the other.

It cannot be expressed, what universal and necessary Use there is of the Consideration of Number, Weight, and Measure, in Common Life. Not to speak of Order, and Beauty, which consist of Symmetry; nor of Building Houses, and Ships: all humane Society is upheld and managed by the use of these. No Commerce, or Exchange, or Trade, can be without them; and consequently, no Benefit of Society.

And therefore, the Sagacity of Learned Men has advanced Arts and
 Scien-

Sciences, for the better knowledge and use of them. For Number, Arithmetick; for Weight, Statics; and for Measure, Geometry. And for finding out the Original Measures of Time (of which I shall have occasion to speak) Astronomy. All Magnitudes are capable of being measured; but it is the application of one to another, which makes Actual Measures; and Things Actually measured.

Measures ought to be Stated and known before they be applied to measure other Quantities. A Measure therefore has reference to something that is or may be measured by it, with application of the Mind. Any given Length of a known Line, under a certain Denomination, may serve to measure out any other Length, be it Equal, or Unequal. A Concave Measure, of known and denominated Capacity, serves to mea-

sure the Capaciousness of any other Vessel: In like manner, To a given Weight, the Weight of all other Bodies may be reduced; and so found out. And Number, in its way, measures them all.

We may measure any Quantity, by any other known Measure of the same kind. But Measures that are most fitting to be applied in this manner for common use, ought to be taken from some Certain Quantity universally known; so that every one may have some Idea of that Measure, though perhaps not perfect.

If we would measure any Length, Breadth, Depth, Height, or Distance; by a Line, Real, or Imaginary, between the two extreme Terms, *A quo*, and *Ad quem*: we must apply some known Measure, wherewith to mete it.

For such a known Measure, the Ancients had recourse to some Original

Patterns in Nature, sufficiently known ; As, chiefly, to the Stature of Humane Body ; and, for Variety of Measures, to Parts of it, reconciling them one to another, by assigning agreeable proportions of the Whole to its Parts, somewhat near Truth, to make them Originals , for Authentick and Usefull Measures. The Parts were especially, The Arm, Hand, and Foot. The Arms, spread cross in a streight Line, and measured from the end of the long Finger on one Hand, to that of the other ; made a Measure equal to the Stature, and is named a Fathom. Half of that, viz. from the end of the long Finger of either Arm , so spread , to the middle of the Breast is, with us, called a Yard. From the tip of the Elbow , to the end of the long Finger , is half a Yard, and a quarter of the Stature , and makes a Cubit ; the first Measure we read of, the Ark of Noah being Framed and

Measured by Cubits. A Foot (the Length of it) is a sixth part of the Stature, and a Measure much used. A Span, $\frac{1}{2}$ of it. A Palm, or Hand's breadth, $\frac{1}{4}$: A Thumb's breadth, or Inch, $\frac{1}{7}$: A Fore-finger's breadth, $\frac{1}{8}$: And other such Measures. Now, tho' all these may not be found exactly in those Proportions; yet, to suppose them such, makes them fit Patterns of Measure, being made Commensurate; The less being *aliquot* Parts, or composed of *aliquot* Parts, of the greater.

Then, Measuring Land, by walking over it, they styled a Double-step (i. e. the Space from the elevation of one Foot, to the same Foot set down again, mediated by a step of the other Foot) a Pace, equal to 5 Foot; a Thousand of which Paces made a Mile, which is a Measure serving for any distance on Earth, and even for the Height of the Sphears.

Likewise for small Measures, they considered a Barley-corn ; the Breadth of it $\frac{1}{2}$ of an Inch, and the Length $\frac{1}{2}$; And less than that, The Breadth of an Horse's-hair taken from the Mane, 48 whereof set in Breadth, are supposed to make an Inch.

These are Originals ; from these our Measures of Length are taken ; but I cannot call them Standards ; for Standard Measures must be Certain and Fixed ; and are made by Consent and Authority of every Nation for it self, and the People in it, For though the Measures before spoken of be known to all, and give a gross Conception of all Measures derived from the Natural Inch, Foot, Cubit, &c. yet they cannot be so exactly stated, but you must imagine a great Inequality, if every Man should measure from his own Thumb, Foot, or Cubit. And therefore several Nations (though intending to follow a

mean)

mean) happen to pitch upon several Sizes of these parts of Man : and consequently, though they keep the same Denominations and respective Proportions of these Measures ; yet the Inch, and Foot, and Cubit, of several Nations , become to be somewhat different from each other : As, *e. gr.* The English Foot is somewhat shorter than the Parisian , and longer than the Roman Foot.

And therefore the Consent, and Government of each Nation Enact by Authority of Laws, what shall be accounted the Measure of a Foot, and of the rest proportionably ; and make Authentick Models of those Measures to be publicly kept, and be the Standard of all private Measures of the same kind, and by which every Man under that Government is to guide himself.

And thus it is in Weights. They began at a known Body, a Barley-corn,

corn, the Weight whereof is therefore called a Grain; which ariseth, being multiplied, to Scruples, Drachms, Ounces, Pounds, &c. and then those Weights, (as they happen to take them) are fixed by Authority, and Exemplars of them publicly kept.

And it is the like in Concave measures. The capacity of the Shell of a midling Hen's-egg, may be the Original from whence Pint, Quart, Gallon, &c. are made Patterns for all Capacious measures; and their authentick Fabricks stored in Public for every one to make his Measures by, and by which to have them examined.

Now although (in these Instances) a Hair, and Barley-corn, and Humane Body, and a Hen's-egg, be truly Original and Radical Measures, universally known; and so give us a gross Idea of those other stated Measures derived from them; yet these cannot be

styled Standard-measures, because they are not universally fixed, but are Unequal amongst themselves, and unequally taken by several Nations. But Standard-measures are National, taken from those Originals (with such Diversities as shall happen) and constituted, as every Government shall think fit to Ordain, and make known unto their Subjects. The Original-measures are found in Nature, not accurately fixed, but subject to some variety: The Standard-measures taken from them, with some Analogy to them, are firmly settled by Consent and by Authority, with some diversity in the several National Establishments.

This is premised, for the better Clearing of that which is my more proper Subject, *The Measures of Time*. For which, because we do not find any Universally known, and Imitable Original here below on the Earth,

be.

because it is of a different and more subtil nature, than those other afore-said Measures; we must therefore seek above, and have recourse to the Motions of the Celestial Bodies; reckoning our Time by numbring the successive parts of those Motions; and herein, if we will be accurate, we may take the most Equal Motion, by which to Measure; viz. That of the *Primum Mobile*. But that being difficult to measure, we do, and may best take our Measures for common use from those Heavenly Bodies, which carry Light along with them, to guide us in the observation of their Motions. And those are (most eminently) the two great Luminaries, the Sun, and the Moon. The Diurnal, and Annual Revolutions of the Sun, which to us are the Measures of Day, and Year; and the Synodic Revolution of the Moon, by which the Month is measured. These Motions are, to us,

the Original and Radical Measures of Time. And the Day, Month, and Year, measured by them, and best known to us, are used as Standard-measures; as likewise others Arbitrarily, and Artificially deduced from them, by Partition, or Collection, and being reducible to them: as, Minute, Hour, Week, Month of Weeks, Solar-month, &c.

As if it be asked, How much is the Length, Breadth, Height, Depth, or Distance of any thing given? I must answer, (not by the Original, but by the aforesaid Known, Denominated Standard-measures) so many Inches, Foot, Cubits, Fathoms, Furlongs, Miles, &c. as the Quantity proposed shall require. So if I be asked concerning Duration; How long is the Age of a Man? The common Answer must be (with the Psalmist) *Threescore Years and Ten*; which are indeed measured by the Time, so long

long as the Sun is in making seventy Revolutions round the Ecliptic ; which Revolutions we, by Divine and Humane Authority, call Years, as a Stated Measure of Time ; by which we keep our Accounts. And in the same manner, less Durations are measured by Months, or Weeks, or Days : And if they be yet less, Then by the Parts of a Day, viz. Hours, Minutes, &c.

The Celestial Motions numbred by an Act of the Mind, as the Parts of them succeed one another *secundum prius & posterius*, are the Original Measures of Time ; and by help of the Lights in the Firmament, are so perceptible, and easily known to us by the Interchanges of Light and Darkness, and Succession of Seasons, and Termination of Revolutions, and the manifest Effects of them : that from thence we have a more Familiar, Secondary Measure of Time, a kind

kind of Standard-measure of all other Motions, or Rest, or Duration, alluding to those other Standard-measures spoken of before (but with some Differences which I shall touch upon.) And these are principally, the Day, the Lunar Month, and the Year.

I do not intend to fall upon nice, Philosophical Disquisitions about the Nature of Time, and Curious Questions relating to it : But upon the Use of it, *in Vita communi*; from the visible Secondary Measures thereof, agreed upon, and practised, according to both Divine and Humane Institution.

If the Revolution of the *Primum Mobile* be (to the Curious) the first Equal Standard-measure of Time, and we may have such a Conception of it ; yet I see not how we can so easily discern, and usefully apply this Motion, as a Measure of Time ; but remotely by the guidance of the Lights in the Firmament. For the Light of those

those Bodies doth immediately discover to us the Succession of their own Motion; and Mediatly that of the *Primum Mobile*, whose Parts are numbred upon the Degrees of the *Aequator*. Where we treat more generally of Time, the nearest and easiest way is, to be guided immediately by those Lights; and make the Day, and Month, and Year, our Measures of Time.

And as all other Measures of Time are reducible to these Three, so we labour to reduce these Three (though strictly of themselves Incommensurate) to one another, for Civil use, measuring the greater by the less, viz. the Year by Months, and the Year and Month by Days, and Parts of Days: So that they may be indifferently used as one agreeable Measure of Time, greater or less, as there may be occasion to apply the Measure.

There is a great Difference, which renders the Account of the Measures of Time to be of much more difficult and curious Contemplation, than the other; because the other Original Measures are to be found every where on Earth, and the Standards of them Arbitrary; whereas both Original, and what we may call Standard measures of Time, are above in the Heavenly Spheres. And because the other Measures, before spoken of, are of Continued Quantity, Permanent, and Visible, and for the most part Tractable; whereas Time is always Transient, in a continual Flux, neither to be seen, nor felt, nor reserved; but only measured by an Act of the Mind, by Observation, and Application of those Motions which are the Measures of it: We cannot keep by us settled and Permanent Material Standards of the Measures of Time, as we do of the other.

There is another Difference. That the Heavenly Motions, (though intricate) are more Stated and Certain, than the Terrestrial Models of the Measure of those other Quantities before discoursed of, and are indeed both Originals, and Standards. And, if we will also call the Day, and Year, Standard Measures, it is because they are Unalterably Constituted by those Motions, and are better known to us, whilst we follow that Light which goes along with those moving Bodies; and because they have some Stamp of Authority from the Almighty Lord of Heaven and Earth, and from Regulations of the Calendar by Public Authority in several Governments.

And though, from the former of these Differences, I conceive, we cannot so properly call the Celestial Motions, Standard Measures; because we cannot make any such Standing Measures

asures to be reserved, and kept for Public Use, and produced when we please, that they may be resorted unto, and applied to the Measures which are used; as is done in the Material Standard Measures, and Weights; as Yard, Gallon, Pound, &c. Yet from their Certainty (which is the other Difference) we may in some manner look upon them as a kind of Standard Measures; because all Measures of Time are reduced to those we commonly use: But they are improperly called Standards, because (as was said) they cannot be made Standing Measures; for to be such does not comport with the Nature of Time.

I had rather call them *Stated Measures*; and we may conceive them to correspond with, and supply the use of those other kinds of Standard Measures: and having also some Stamp of Authority, by which they are Settled,

led, and Stated, something also different from Nature.

For, as was said of Measures of Length, and of Capaciousness, and likewise of Weights: So here also, the Measures of Time, are (in their way) subjected more or less to Civil Sanction. Thus in *Rome* (not to speak of other Nations) *Romulus*, and *Numa*, and, after them, *Julius Caesar*, Ordered, and Constituted the Account, and Computation of Years, and Months; which last Order we of *England* still follow, though in long Tract of Time, some Anomalies are crept in, which makes our Calendar vary from the true Account of Time.

There is one remarkable Instance of this, how we measure our Time by Law, and not by Nature, and that is the Solar Month; which tho' it be no Periodical Motion, and not easily Mensurable, and the Months unequal amongst themselves, and not

to be measured by Even Weeks, or Days; as naturally consisting, according to the Mean Motion of the Sun, of 30 Days, 10 Hours, and near half an hour : Yet by Civil Sanction, and Constitution, this is made to us, the chiefest Measure of the Year. And these Months are measured by Integer Days, though unequally; some by 31 days, some by 30, and one by 28, and every fourth Year, by 29. This Solar Month, I say, is by Civil Sanction and Authority, notified in Authentic Calendars, made for our use the chief Measure of the Year : a kind of Standard, by which we measure out our Time. But these Months do not so much come under my Consideration; but more properly, in order to Ecclesiastical Computations, the Lunar Month; which is Natural, and Periodical, and by which the Moveable Festivals of the Christian Church are regulated.

We read in *Moses*, *That God created Lights in the Firmament of Heaven, to divide the Day from the Night, and appointed them for Signs, and for Seasons, and for Days, and for Years.* Gen. 1. 14.

The visible Motions of all the other Lights of Heaven might afford us several Measures of Time, if we could number them. But because most of those Motions are not so evident to us, and the great Lights are sufficient, and serve also to measure even the Motions of those other ; we therefore, following the Guidance and declared Design of the Almighty Providence, deduce our Measures of Time from the successive Motions of the Sun and Moon, and most from the Sun : Both of them having Signal Motions, and giving sensibly Apparent Signs ; the Sun of Seasons, and of Light and Darkness, *i.e.* of Years, and of Days ; The Moon of her changeable Habitues to the Sun, and conse-

quently of her Phases, or different Appearances to us, and of her Seasons. For she makes also four Quarterly Seasons within her little Year, or Month of Consecution. I need not add, how Generally, and how Much, those Quarterly Seasons of the Moon are observed.

C H A P. II.

Of the Sun's Motion; Measuring Days, and Years: and making them our Ordinary Measures of Time. § Difficulties of Accounting by them. § The Inequality of the Sun's Motion, and of Solar Days briefly mentioned. § From Day and Year other Measures derived. § And their Usefulness. § The Division of a Circle into 360 Degrees.

WHether the Sun actually moves out of his place, or else is fixed upon his own Center, and only seems to move, and the Motions be attributed to the Earth, after the Copernican

pernican way; which of late is more generally favoured, because it does much better, and more easily solve all the *Phænomena*: Yet it is still the Sun, which (according to the Scripture) by his Light governs the Day, and by his Light and Heat makes the Seasons of the Year; and terminates to us, and discovers unto us the Revolutions of the Earth, (supposing the Motion thereof) both in it self, and also about the Sun. And it is all one, as to our Sight, and Calculation of Time, whether the Motion be attributed to the Earth, or to the Sun: As the Distance is still the same, whether we fancies the Shore to recede from the Ship, or the Ship to move from the Shore,

I shall therefore in this Discourse, (because of Prepossession of the one, and Prejudice against the other) suppose the Sun to move according to the *Ptolemaic* System.

First then, from the Motions of the Sun, as Original Measures, are constituted for our use, Two most Signal, Universal, Natural, Distinct, Perceptible Measures of Time; which are as Standards for us Mortals to measure our Time by: And these are, the Day, and the Year.

The Day, *i. e.* the Natural Day, *Nux Simulægr*, though it be accounted in General to be measured by one whole Revolution of the *Primum Mobile*, and with it of the Equator, upon the *Axis* of the World: Yet more precisely, and truly, it is measured by the Revolution of the Sun, carried along with the Motion of the *Primum Mobile*, upon the same *Axis*, either in the Equator, or in less Circles, very near Parallel to the Equator, which are therefore called Parallels.

For the Day, being visibly governed by the Sun, is a little longer than the Revolution of the Equator: so much,

much, as is occasioned by the Advance of the Sun in his Annual contrary Motion along the Ecliptic, in that Space of Time; which is about one Degree of the Ecliptic, and which the Sun passeth in about four minutes of an hour.

I say, the Solar Day, from the Meridian of a Place on Earth, round to the same Meridian again, is a little longer than the same Revolution of the Equator: viz. so much longer, as the same Point of the Equator is returned sooner to the same Meridian, than is the Sun; which in that Space of time, by his Annual contrary Motion Eastward, will be advanced near a Degree of the Ecliptic, cross to the Motion of the Equator.

As, suppose the Sun to be in the first Point of *Aries*, i. e. in the Equinoctial; then, by what time the first Point of *Aries* will be carried round with the Diurnal Motion of the World,

World, contrary to the Order of Signs, from one Meridian to the same again: In that time the Sun will be advanced, as was said, near one Degree of *Aries*, contrary to the other Motion; and so will be found distant from the said first Point, about a Degree, and will require about four minutes of an hour, to be brought back, by the Motion of the *Primum Mobile*, to the same Meridian: *i. e.* The first Point will return to the Meridian sooner by about four minutes of an hour, than the first Degree of *Aries*, whereabout the Sun will be found at that time. And so much the Sun's Diurnal Motion is longer than the Revolution of the Equator.

As a Natural Day is measured by the Revolution of the Sun, from any one Meridian to the same Meridian again; So a Year is measured by the Motion of the Sun round the Ecliptic, upon the *Axis* of the same, from one Point

Point of the Ecliptic (suppose from the first Point of *Aries*) to the same Point again : And this Revolution is performed Obliquely, and Contrary to the other ; so that the Day and Year seem not to correspond with, or regard each other.

The Year is measured to us by the Revolution of the Sun in the Ecliptic ; The Day by his Motion in, or Parallel with the Equator : The Year by the Sun's Motion Eastward in *Consequentia*, or, *secundum Seriem Signorum* ; The Day by his Motion Westward in *Antecedentia*, or, *contra Seriem Signorum*.

The Day is no *aliquot* part of the Year (strictly speaking) neither to Compound, or Divide the Year, so much as by Units. If the Year comprehend Days, it is but as any Greater Space of Time may be said to comprehend a Less, though the Less Space be Incommensurate to the Greater.

And from these differing Properties of Day and Year, arise Difficulties in carrying on and reconciling the Supputations of Time, especially in long Measures. Although it must be confessed, that for Vulgar Use, where is no need of, or regard to Exact Calculation; we have no better Measure of a single Year, than the Day, and the Artificial Solar Month, consisting of Even Days: Because the Succession of Days is so visible, and so easily Numbred, that by these we may keep as good an Account of the Year, as is needfull to our Common Occasions.

But if we thus measure many Ages of Years by Even Days, our Computation will be perplexed.

For the Year (without regard to Days) ends, and is terminated with an odd day, and odd hours, and odd minutes, and odd second minutes; if we go no farther: So that

it cannot be measured by any even Number of Days, or Hours, or Minutes.

The Circle of Degrees in the Ecliptic, which make a Year, are 360; the Circle of Days within a Year is broken into 365, and almost a Quarter. The Sun is carried round the World backward (the daily Motion compared with the Annual) 365 times, and almost a Quarter, while he makes his own Round forwards of 360 Degrees of the Ecliptic: So no Circle of Even Days can make a Year; which (as was said) creates difficulty in keeping account of Years.

And the very Steps which the Sun appears to us to make through the Ecliptic, are Unequal; as also the Days, if one be compared to another successively throughout the Year, are found not to be Equal, and will not justly correspond with any Artificial, or Mechanic Equal Measures of Time;

Time ; as by Watch, Clock, &c.

So that we are to find out the Extremities on both Sides, and from, and between them, the Middle dayly Motions of the Sun along the Ecliptic ; and to frame Tables of Equation of Natural days to be applied to the mean Motion, by Addition, or Subtraction, as the Case shall require : which are styled *Prosthaphareses* ; The Greek word *μεγαλαφαρες* being fitted to comprehend both Addition and Subtraction.

The Day is limited to us by the Interchanges of Light and Darkness ; and the Year by the successive Seasons of Winter, Spring, Summer, and Autumn : And these are Signal and Certain (tho' not Original) Measures of Time, constituted by the Revolutions, and manifested to us by the Light of the Sun. And we have no other Measure, (save one of the Moon) but are, as we say, Artificially made out of these by Compounding or Dividing them. No other

ther Measure of Time deduced from any other Original than the Motion of the Sun, can be so evident to us: For these are apparent, at least after a gross manner, to all Mankind, and to almost all Living Creatures; others only to the Learned in Astronomy, or else derived from these by Institution for Civil Use.

And from these *Constituted Measures*, and Denominations of Time, viz. Day, and Year, (not excluding the Lunar Month) all other Measures of *Duration*, or *Successive Motion*, are Artificially contrived for Civil Use; by dividing *these* into less parts, or Collecting and Compounding them. The Day for Small Measures, chiefly by Partition, and the Year for Great, by Collection of Numbers of Years: Or we may measure by Numbers of Days, and Parts of a Year.

Some divided the Natural day, comprizing Day and Night into four
Parts.

Parts, or Quarters for the Day, and four for the Night; and each of these Quarters consisted of three Planetary Hours: The Artificial day from Sunrise to Sunset (be it longer or shorter) being divided into 12 Equal Hours; and the Night likewise into 12: Three of which Hours made one Part, or Quarter. But the Hours of the Day were always unequal to the Hours of the Night, according to the Increase, or Decrease of the Lengths of Days and Nights: Only if the Sun were in the Equinoctial, or the Inhabitants under the same; then the Days and Nights being Equal, so would the Hours be also.

But the General Usage is, to divide the whole Natural day into 24 Equal Hours, an Hour into 60' (Minutes) a Minute into 60" (Second Minutes) a Second Minute into 60''' (Thirds) and so on.

And by thus dividing the Day; we compute the smallest Measures of Time : and by Compounding Years, we measure the Greater Spaces of Duration.

But we must observe, that the Day is not thus divided by Nature, as it is into Light, and Darkness; and by the Meridian into Noon, and Midnight : But this Division (as most others are) is Artificial, and at our pleasure, by Consent of Nations.

We may observe likewise, that the common Division of a Circle, into 360 Degrees, or Parts, is also Artificial, and Arbitrary : But it is well chosen and pitched upon, as being a Number that abounds with Integer *Aliquot* Parts, and therefore most apt for Partition; and being, as near as may be, suited to the number of Days, which the Sun makes in a Year, in compassing his whole Circle of the Ecliptic; viz: 360, to 365. And in

D

both

both respects it is best fitted for Astronomical Uses.

Of the former of these, the *Aliquot* Parts of the Number 360, take a short View, as follows ;

1 — 360	8 — 45
2 — 180	9 — 40
3 — 120	10 — 36
4 — 90	12 — 30
5 — 72	15 — 24
6 — 60	18 — 20

In toto 23 several *Aliquot* parts.

The Number 6, is celebrated for having all *Aliquot* Parts; viz. 3, 2, and 1; and for being composed of the Aggregate of them all; and therefore is stiled, The Perfect Number.

And 10 is the first of the Saracenic Characters, or Figures with Cypher, that great Friend to Calculation; or rather, which changeth Calculation, strictly

strictly so called, into easie Computation. Now the Number 360 consists of the Square of 6, viz. 36, multiplied by 10, or having a Cypher added to it.

Of these 360 Degrees, or Parts of a Circle, every one may be supposed to be subdivided into Minutes, Seconds, Thirds, &c. And these Parts are marked alike with the Parts of an Hour, ex. gr. For Hours; 3^h , 2^h , 5^{th} , 4^{th} , and so onwards: For Degrees; 3^G , or 3° , 2° , 5^{th} , 4^{th} , &c. i. e. 3 Hours, or 3 Degrees, 2 Minutes, 9 Seconds, 4 Thirds; and so forwards: A Minute being $\frac{1}{60}$ of an Hour, or of a Degree; a Second, $\frac{1}{60}$ of a Minute; a Third, $\frac{1}{60}$ of a Second; &c. So that one Hour, or Degree, contains $60'$, $3600''$, $216000'''$, and as many Fourths $'''$, as is the last Number multiplied by 60; viz. $12960000''''$; almost 13 Millions.

By Composition, or Joint Number of Days, besides such as have been formerly in use, we have now chiefly, the Week, made of seven Days; and a Month, made of 4 Weeks, or 28 Days.

By Partition, or Gross Dividing of the Year, we have the 4 Quarters, or Seasons of the Year; we have 12 Calendar Months intended (however now Unequally constituted at Pleasure) to measure the Movement, or Passage of the Sun through every of the 12 Signs of the Zodiac.

Lastly, by Compounding, or Numbering Years, we keep Account of Ages, and Publick Transactions, and Memorable Accidents: we make Cycles, and Periods of Years; as Decads, Centuries, Chiliads, &c. chiefly for the use of Computations in History, Chronology, Astronomy, &c. The Numbers of Years, by which we measure the Spaces of Time; having their
several

several *Epocha's*, or Beginnings ; as, from the Creation of the World ; from the Flood ; from the first Olympiad ; from the Building of Rome ; or from any remarkable Passage, or Accident, giving us a pleasant Prospect into the Histories of Antiquity, and of former Ages.

We Christians make the Reputed Year of the Nativity of our Blessed Saviour our chief *Epocha*, from which to make our Dates, brought in use first by *Dionysius Exiguus*, Abbas, who lived in *Justinian's* Reign, about the Year of our Lord 528 : And tho' his Computation may perhaps differ two Years from Truth, as *Helvicus* ; or more Years, as others are of opinion ; yet since it is, and has been universally received over all Christendom, our Compute by it is, as for the use of it, Certain, and not liable to any Error or Mistake. It was stiled *Æra Dionysiana*, or, *Æra Christiana*, and

D 2

after-

afterwards *Vulgaris* was added to it, to distinguish it from *Æra Christiana Vera*, as contended for, though never in use.

Till then, the Accounts in use were, the Olympiads, the Consuls, *Urbs Condita*, Indictions. The Olympiads were a small Cycle, but of four Years, still repeated, and numbring withall the Repetitions: But *Iphitus* made them an *Æra*, by accompting a continual Series of Expanded Years from the first Olympick; and they were used both ways, but chiefly the Olympiads, by Quaternions.

C H A P. III.

Of Epocha's, Cycles, or Periods. § Of the Dionysian Period. § Of the Cycle of the Sun; and Changes of the Dominical Letter. Containing also an Account of the Week; and Bissextile, With a Table of the Dominical-letter, &c, § Some other Periods; particularly, that called the Julian. § The Indiction. § Some Principal Era's, and Periods; with a Table, reducing them to the Year of our Lord.

HERE, if I may have leave to Digress, and take in Notions, though not so Pertinent to our present Design; yet equally Profitable and Usefull to Young Students, for whom this Discourse is intended: I would in this Place say something more of Epocha's, and Periods.

And, first, I take Epocha to be the Head, or Beginning, (the Pause, Ἐπαχή,

or Stop, if you reckon up, or backwards as far as you can :) And *Æra*, the Continuation, or Series of any Account of Years; which is, or may be supposed to be Extended, and Numbred onwards, as long as Time shall have a Being.

Secondly, a Cycle, or Period, is an Account of Years that has a Beginning and an End too; And then begins again and again, as often as it ends; and so obtains a Perpetuity. The *Æra* has but one Beginning, which is the *Epocha*, if we speak strictly, though the Words are often Promiscuously used: And from thence a Continual Extension.

The Cycle, or Period, has its Continuation by beginning again as oft as it ends, going as it were in a Circle, and thence it has its Name. Thus the Cycle of the Moon, after every Space of 19 Years, begins again, *toties, quoties, in infinitum*. I think we do more

commonly use these words so, as to stile a lesser Space, a Cycle, and a greater by the Name of Period; and you may not improperly call the Beginning of a large Period, the *Epocha* thereof. For the Derivation of these Words, *Epocha* and *Æra*, I refer you to the Etymologists.

The aforesaid *Dionysius* (or, as some affirm, *Victorius Aquitanus*, about 70 Years before him) considering that a small Cycle of Years (by reason of its often Revolution) cannot give so certain a Character of Time, as a large Period; contrived a Period, usefull for Computation, consisting of 532 years; by applying the Cycle of the Sun 28, to that of the Moon 19: which multiplied together, give the Number of 532; beginning as oft as those two Cycles take their Rise together at 1, as they did lately in the Year 1672. *Dionysius* however gave it a new Beginning, by apply-

applying it to the Year of our Lord ; and therefore it was generally stiled, the *Dionysian* Period. This Period has had but 4 Beginnings since *Christ*; viz, *A. D.* 76, 608, 1140, 1672; and this present Year 1693 is the 22^d year of this Period.

As the Cycle of the Moon serves to shew the Epacts, and that of the Sun the Dominical Letter, throughout all their Variations: So this *Dionysian* Period serves to shew these two Cycles both together, and how they proceed, and vary all along, till at last they accomplish their Period, and both together take their Beginning again after every 532^d year.

And it serves farther also (which was the chief Design of it) for more Certain Computation, by how much it is a Larger and more Comprehensive Period, and under a more Undeceiveable Calculation.

The two Cycles, which make this Period, are (or ought to be) very well known to all. One of them,

that

that of the Moon, or Golden Number, is at large explicated in the following Discourse: The other, that of the Sun, so called, because it shews the Sunday Letter, being a Table of Cycle of the Changes of the Dominical Letter; I shall briefly here explain.

Instead of the ancient *Roman* division of the Month, into Nones, Ides, and Calends; we reckon the Days of the Month in Order: And instead of their accounting by their *Nundinae* (*quasi Novendinae*) their Mercates, or Fairs, for the Country-People to come to Town every 9th Day, for Commerce and Trade; and to receive their Laws; (as the *Greeks* reckoned by Ten's, dividing their Month into 3 Parts) we, as the *Hebrews*, number our Days by Weeks, and their Returns, after every 7 Days; which the *Jews* did in relation to their Sabbath, (and possibly the *Assyrians*, &c. in relation to the Quarters of the Moon, consisting each of about 7 days) and we, as Christians, for our Lord's-day. We

We describe the Days of the Week by seven several Names , as Sunday , Monday , Tuesday , &c. And to distinguish them in the Calendar , there are 7 Letters appropriated, and set in Alphabetical order before them , and so repeated throughout the whole Year; viz. A, B, C, D, E, F, G ; and some one of these is the Dominical Letter , or the Letter for Sunday ; and the Letters following for the other Days , as they follow.

But the Sunday Letter is not constantly the same, but is changed once in every Common Year , and in every Fourth, or Leap-year, twice. And the reason is, First, because the Common Year does not consist of just Weeks , but of 52 Weeks, and one Day. So that as the Year begins with A, set before New-year's-day : So it ends with A, set before the last Day. And the Year beginning again at A, there will be two, A, A , falling together,

gether, *Dec. 31* : and *Jan. 1.* and if one of them, (the former) happen to be Sunday, the other in course must stand for Monday; and then reckoning onward, Sunday must fall upon the first following G, and G will be the Dominical that ensuing Year. Thus the odd Day shifts back the Dominical Letter every Year, by one Letter. And this Revolution would be terminated in 7 Years.

But secondly, there comes in another odd Day every 4th Year, being Leap-year. And in that Year there are consequently two such Shifts; the Sunday Letter being changed twice: Once at the beginning of the Year; and the 2^d time towards the latter end of *February*, by Interposition of the Bissextile, or Intercalar Day; called Bissextile, because the 6th of the Calends of *March* is twice repeated. And the reason why this was done in that Month, and not rather at the end of the Year seems to be, because

because by *Numa's* Institution for the better regulating the Year, (in imitation of what the *Greeks* had done before) there had been an Interpolation of several Days, at that very time in *February*.

To take a more easie Account of these Changes, there is appropriated a Cycle, which comprehends in order all the Variations of the Sunday Letter: and is therefore called, the Cycle of the Sun; composed of 4, which makes the Leap-year, and 7, the change of the one odd Day, throughout the *Septimana*, or Week; 4 times 7 gives 28. This Cycle begins at that Leap-year, wherein G and F are the Sunday Letters, and is terminated at 28. By the Table annexed, you may see how it proceeds. I have added to it the Cycle of the Moon, or Golden Number; that you may view their Progress, from their being joined, and beginning together, in the Year 1672.

A.D.	Cyc. ☉	D. Letter	Cyc. ☾
1672	1	G.F	1
73	2	H	2
74	3	D	3
75	4	C	4
76	5	B.A	5
77	6	G	6
78	7	F	7
79	8	E	8
1680	9	D. C	9
81	10	B	10
82	11	A	11
83	12	G	12
84	13	F. E	13
85	14	D	14
86	15	C	15
87	16	B	16
88	17	A. G	17
89	18	F	18
1690	19	E	19
91	20	D	1
92	21	C. B	2
93	22	A	3
94	23	G	4
95	24	F	5
96	25	E. D	6
97	26	C	7
98	27	B	8
99	28	A	9
1700	1	G. F	10
701	2	E	11
702	3	D	12
703	4	C	13
704	5	B. A	14

Et.

It is likely the aforesaid Period was made by *Dionysius* (or whoever else first attempted it) in imitation of *Calippus*, who, many Ages before, in like manner, and for the like reason, joined four of *Meton's* Lunary Decennial Cycles; (what they are, you will see hereafter) out of which he made a Period of 76 Years, which had its beginning at the New-moon, next after the Summer Solstice, after the Victory of *Alexander* the Great over *Darius*.

And in the same manner, after the third Revolution of this Period, *Hipparchus* enlarged it, by adding together four of these *Calippic* Periods, and so obtain'd a greater Period of 304 years, containing 16 *Metonic* Cycles.

Upon the same Principle, but with a greater and nobler Design and Event, *Joseph Scaliger* formed a Period, which is become, as it were, a Standard to all others; including and comprehending them all, and excells them

all for Certainty: because we can, when we please, by Calculation of the Course of the Cycles of which it consists, trace up to the Head, or Beginning of it; and so, infallibly determine in what year of this Period, any given year is to be placed; which by him was thus contrived.

Upon the *Dionysian* Period, formed, as I have shewn, out of two Cycles, viz. of the Sun, and Moon, he grafted another most excellent one, for Largeness and Certainty beyond all other; commencing 764 years before the reputed *Epocha* of the Creation in use with us, & serving for many thousand years: And it was by joining the *Roman Indiction*, a Cycle of 15, to the other two Cycles, i. e. to the Period of *Dionysius*.

The *Indiction*, instituted by *Constantine the Great*, is properly a Cycle of Tributes, orderly disposed for 15 years: And by it Accounts of that kind were kept. Afterwards, in me-

mory of the great Victory obtained by *Constantine* over *Maxentius*, 8. Cal. Octob. 312; by which an entire Freedom, and as it were, a new Life was given to Christianity; the Council of *Nice*, for the Honour of *Constantine*, ordain'd, that the Accounts of years should be no longer kept by the *Olympiads*, which till that time had been done; but that instead thereof, the *Indiction* should be made use of, by which to reckon and date their years; which hath its *Epocha Anno Dom.* 313. Jan. 1.

Now this Cycle, as was said, was by *Scaliger* joined to the other two; making the *Epocha*, or Beginning, when all three Cycles begin together at 1, which comprehends a Period of 7980 years; having its *Epocha* 764 years before that of the Creation now in use: And this is stiled the *Julian Period*. The Golden Number has its Period in 19 years, the Cycle of the Sun in

28, the Indiction in 15 : The two former, as before, multiplied one by the other, give 332 ; which multiplied by 15, gives 7980. This Period is of great use in Chronology, and they apply all other Periods and *Epocha's* to it.

Chronologers differ amongst themselves about most other Great *Epocha's* ; as particularly, that most principal *Epocha* of the Creation, which is accounted by Arch-bishop *Usher* to have been 4003 years compleat before the Vulgar *Aera* of *Christ* ; by *Scaliger*, 3949 ; by *Petavius*, 3983 ; &c.

So that when I read of an Action said to be done in such a year of the Creation, I am in uncertainty, whose Opinion amongst them my Author follows ; and consequently know not what year he means : But the *Julian* Period is so fixed by Certain Calculation of the Revolutions of those Cycles which make it, that it can lie under no Mistake or Doubt, but is

an Infallible Character of that one year ; to which therefore all other *Æra's* must be reduced, as well as we can.

It is necessary to know the different Periods, and *Epocha's* as they were in use amongst several Nations, and to know how to reduce them to our way of Accounting ; else we cannot understand their Historians, as to the true Date, and Time of Occurrences, which they Relate and Account after their own way.

The *Greeks* accounted by the *Olympiads* chiefly, the *Romans* from the Building of *Rome*, and by their *Fasti Consulares*, as the *Athenians* did by their *Archontes*. The *Astronomers* from *Nabonassar*. The *Æra* of *Dioclesian*, or of the *Coptites*, or *Martyrs*, in many places was used until the *Christian Æra* took place ; and is still in use, as *Helvicus* relates, amongst *Arabian* and *Æthiopic* Christians. The *Arabians* and *Turks* account from the *Hegira*, or Flight of *Mahomet*. The *Persians* from *Iezdagird*, &c.

I have,

I have, for this cause, in the following Tables, endeavoured to reduce the principal *Æra's*, and Periods, to the Year of our Lord: Some having their *Epocha's* before the Nativity, and some after.

Scali- ger.	<i>An. Do.</i>	1	1600	1695	1700
	<i>Julian Period.</i>	4714	6313	6408	6413
	<i>Creation.</i>	3950	5549	5644	5649
	<i>Judaic Period.</i>	3761	5360	5455	5460
	<i>Deluge.</i>	2294	3893	3988	3993
	<i>Exodus Egypt.</i>	1498	3097	3192	3197
	<i>Troy Destr.</i>	1183	2782	2877	2882
	<i>Solomon's Temple.</i>	1018	2617	2712	2717
	<i>Olympiad.</i>	1. 195	4. 594	3. 618	4. 619
	<i>Iphitus.</i>	777	2376	2471	2476
	<i>V. C.</i>	753	2352	2447	2452
	<i>Nabonassar.</i>	749	2349	2444	2449
	<i>Julian Calendar.</i>	46	1645	1740	1745

<i>Heads of some Æra's after Christ</i>	<i>A. D.</i>	<i>Years expanded since, to the Year of our Lord.</i>		
		1600	1695	1700
<i>Destruction of Jerusalem.</i>	70	1530	1625	1630
<i>Dioclesian's Æra.</i>	284	1316	1411	1416
<i>Indiction.</i>	313	^{13.} 1287	^{3.} 1382	^{8.} 1387
<i>Hegira.</i>	622	978	1073	1078
<i>Jezdagird.</i>	632	968	1063	1068
<i>Conquest.</i>	1066	534	629	634
<i>Calendar reformed.</i>	1582	18	113	118

As to these Tables, the Reader may observe, that Authors differ about fixing some of the principal *Æra's* (as I said before) especially that of the Creation; about which many Learned Men dissent from one another. But chiefly, the Account of the *Septuagint*, and that likewise which a great part of the Eastern Churches do follow, and the Western did even after St. *Jerom's* time; are very widely distant from that used by us at present, grounded (as 'tis thought) upon a different Reading of the Ancient Text of the *Hebrew Bible*, where it relates to the Lives of the Patriarchs, and some other Circumstances. And as the Number of years are differently computed, so the Years themselves also have different Beginnings; some in Summer, and others in Winter, &c. and consequently, some about the middle, compared with other years: whence one half of such a year seeming to belong to the preceding, the other to the following year of another *Æra*; the *Epocha* thereof is placed by some a year sooner, by others a year later. So that by reason of these, and other Confusions incident to Chronologie, it is very difficult, I may say beyond humane Industry, to come to an Exact and Correct Determination; and therefore every one may, and will take leave to abound in his own sense.

C H A P. IV.

Of the Day as applied to measure the Year. § Different Accounts of Years among the Ancients, and Confused. § The Julian Year. § Inequality of Natural Days; and Reasons thereof; With a short Table of Equation.

HAVING no visibly distinct Periods, or Measures of our Time for all other Motions, but the Day, and Year, and Lunar Month; the Day is best known to us, being but of a short and easie observation, and having so visible change of parts and easie to be measured by Mechanic Motions: But the Year is more obscure; though we are sensible of the Seasons, yet it is hard to find the Beginning and End of it. We are therefore constrained to make the Day serve to measure the Year as well as

we can , though not commensurately to each year (as has been shewed before) but by collecting the Fractions of Days in several Years , till they amount to an even Day ; and then, by Addition or Subtraction, reducing the Year as near as may be to his just course.

I say, by Addition, or Subtraction of a Day, (when it is so collected) to or from the Account of the Days of the Year at certain Periods : As , at every Fourth Year to add the Bis-sextile-day, and at every Period of about 134 Years, to omit it ; which is to subtract it : Not regarding the smaller Inequalities in the mean time all along , which will never exceed the compass of a Day , before the Year be set right. For the reason of this Subtraction, see more afterwards.

This uneven Measure of the Year , by collection of Days, and the Measure not being then so perfectly known

to the Ancients, rendered it very difficult for them to keep a just Account of Years, and to transmit a true Chronology to succeeding Ages.

Their Civil Constitutions of the Year were after different manners in several Nations; some using the Sun's Year, but in divers fashions; and some following the Moon, finding out *Embolism's*, or Equations, even to the addition of whole Months, to make all as Even as they could.

But it may be thought, that whatever Methods the Ancients did apply in their Computations, and Settlements of the Spaces of Years; yet they might probably have been kept in some Bounds of their Accounts, by the visible Characters of those Stated Measures, *viz.* Day, and Year; and most especially of the Year.

For the Night and Day always made a Natural Day of 24 hours, in all places remote from the Unhabitable Poles

Poles of the World; and Winter and Summer always measured a Year: So that, if they observ'd but Winter and Summer, they could not lose a Year in their Accounts, though they were perhaps not able to measure the Year exactly by Days; therefore it was as usual to them to express a large Space of Time, by so many Winters, or Harvests, as by so many Years. I must not dissemble, that they who inhabit just under the Line, may seem to have two Winters, and two Summers: But there also they have four Interchangeable Seasons, which is enough whereby to measure the Year.

But at last *Julius Cæsar*, a year before his Death, and 44, or 45 before *Christ*; with the help of *Sosigenes*, an *Ægyptian*, universally settled the Account of the Year; which we of *England* follow to this day; and which from him is stiled the *Julian* year.

He supposed the Solar year to contain just 365 days, and a quarter, or 6 hours; and ordered the continuance of the Account of years, by adding a day to every fourth year, collected from the odd six hours, remaining above 365 days at the end of the year; making three years successively to consist of 365 days, neglecting the odd 6 hours; and the fourth year (*Bissextile*, or Leap-year) of 366 days; making thus (as he thought) a perpetual Equation of the yearly Account.

Having, before, taken notice of the Inequality of Natural days; I shall, before I pass farther, say somewhat more of it in this place.

It is to be thought, that of himself, the Sun moves Equally through the Degrees of the Ecliptic: But by reason of the Sun's Excentricity to the Earth, and Obliquity to the Equator; he appears to us to move Unequally. The Sun passeth 360 Degrees of the Ecliptic,

Ecliptic, *i. e.* round it, in 365 days, and almost a quarter of a day: So it is plain, that the Sun does not pass a whole Degree of the Ecliptic in a day, one with another, but somewhat less, *viz.* $59^{\circ} \cdot 8''$: but he is found sometimes to exceed that Number, and sometimes to fall short of it.

So that 59° and $8''$ must be called his Middle, or Mean Motion, being between his two Extrems, of sometimes going faster, and sometimes slower, which makes the Inequality of Natural days. About the Summer Solstice, being in his *Apogæum*, he is found, by Observation, to pass but 57 Minutes in a Day: And at the Winter Solstice, in his *Perigæum* 61° , according to his Apparent Motion.

The Consequence whereof is, That the Natural day of 24 hours is shorter in Summer than in Winter: So that the Sun is 8 or 9 days longer in passing the Northern half of the Ecliptic

cliptic, than the Southern. Take but your Almanack, in hand, and number the days of the Sun's passage between the Equinoctial Points, and you will find, that from the Sun's Entrance into *Aries*, to his Entrance into *Libra*, are about 4 or 5 hours above 186 days: And from thence to his Entrance into *Aries*, are so much less than 179 days; 7 or 8 days difference. Which Entrances vary every year, as Influenced by the Unequal Measures of the *Julian* year, in respect of the Leap-year, and the three following years.

This, in general, might be supposed to be caused by the Sun's Excentricity to the Earth; but amongst Astronomers, there is a farther account of Inequality of days, and lately confirmed by experience of our Watches, and Clocks; which has 4 Periods in a Year, and seems so Irregular, that Excentricity alone cannot solve

solve it, which else might answer the
 general Variations by Half-years: But
 this having four Periods in a Year,
 must have another joint Cause, which
 is the Obliquity of the Ecliptic to the
 Equator, and from thence, the Diur-
 nal differences of the Sun's *Right A-*
scensions; which finish their Variations
 in each Quadrant of the Circle of the
 Ecliptic: and this being joined to the
 former Inequality, arising from Excen-
 tricity, makes these Quarterly, and
 seeming Irregular Inequalities of Na-
 tural days. But yet these Differences
 are not so sensible to us, as to give a-
 ny disturbance to our Account, and
 Use of Natural days; but rather af-
 fect the Measures of the Seasons of
 the Year.

This Inequality hath been diligent-
 ly observed by several of our Ingeni-
 ous Clock-makers, and Equations been
 made and used by them. But the most
 Authentic Tables of Equation of Na-

tural days are handed to us by the Skill and Diligence of our Great Master in Astronomy, Mr. *Flamsteed*, and published in Mr. *Parker's* Almanacks for the Years 1692, and 1693. Out of which we may take a Compendious View only of the Days of Extreme Inequality, and of the Mean between them; referring to the whole Table for a daily Account.

Supposing a Watch, or a Clock, to be made and set so exactly to correspond with the Day of the Middle Motion of the Sun, that it will continue to go truly according to that Motion of the Sun for a whole Year; the Sun's days sometimes lengthning, and sometimes shortning (I mean the Natural days) the Accounts of the hours in the Sun-dial will vary from those of the Equal going Watch, according to the Table following.

Month.

Month.		Equation.		Watch.
<i>Jan.</i>	31	14'	49''	<i>Too Fast.</i>
<i>Apr.</i>	4	0.	0	
<i>May</i>	4	4.	13	<i>Too Slow.</i>
<i>Jun.</i>	6	0.	0	
<i>July</i>	15	5.	46	<i>Too Fast.</i>
<i>Aug.</i>	19	0.	0	
<i>Oct.</i>	22	16.	1	<i>Too Slow.</i>
<i>Dec.</i>	12	0.	0	
 <i>Jan.</i>	 31	 14.	 49	 <i>Too Fast.</i>

C H A P.

C H A P. V.

The Deficiency of the Julian Year, and Calendar. § And from thence, Defects in our Ecclesiastical Computation; and, how to Reform it.

BUT, to come nearer to our purpose, in reference to the Calendar. There is, in this long tract of time, a great Incongruity crept into our Calendar, by the Deficiency of the *Julian* Year, as we measure it.

The true Solar Year is computed to be constituted of 365 days, 5^h hours, 49' Minutes, and 16" second Minutes; so it falls short of the odd 6 hours, by 10' 44": The *Julian* Year is made to consist of 365 days, six hours, neglecting the odd Minutes; which neglect, in tract of time, has made a considerable Variation.

For the odd Deficient Minutes (Deficient, I mean, in the true year, from the *Julian* year of 365 days and full 6 hours) viz. 10' 44" multiplied by 134, as being collected in so many years, arise to 24 hours, or a whole day: And as many times 134 years as are passed since *Julius Caesar's* time, so many days will the true Account of the Sun's Motion, and the Seasons caused by it, vary, and fall sooner, than by the *Julian* Account.

We of *England* retain the *Julian* constitution of the year (as at first established throughout the *Roman* Empire) Unreformed, without consideration of the said defective Minutes, and continue our Accounts by it, making our Dates, *Stylo veteri*, as they who follow the *Gregorian* Reformation do *Stylo novo*. They have set their Calendar 10 days forward, making our tenth of *March* their twentieth; so that the Equinoctial day, and all the other Accounts fall

10 days sooner in our Calendar than in theirs; and will still in tract of time fall sooner, till it be reformed.

In *Cæsar's* time, the true Vernal Equinox, or Sun's entrance into *Aries*, was reputed to be about *March 24th*; which now by the aforesaid Defect of $10' 44''$, is fallen back to about the 10th. of *March*.

The *Ecclesiastical* Computation of the Moveable Feasts regards the time of the *Nicene* Council, *Anno 325*; at which, *Easter-day*, on which the rest depend, was settled and fixed, to be always on the first Sunday after the first Full-moon after the *Vernal* Equinox.

The Equinox was then on *March 21*; and in regard that we are now guided, not by the true Equinox, but by the *Nicene* Rule, which supposed the Equinox to be always the 21 of *March*, and we still follow the same Rule: It hath caused a great *Anomaly*,

or Irregularity in our Calendar, and wants to be reformed, and the Equinox to be rightly computed, as was designed in the *Gregorian* Reformation. And being once reformed and set right, it may be kept so (as to the Sun) without any considerable variation, for many Ages; by omitting one Leap-year, *i. e.* the Additional day, at the end of every 134 years: As we add a day every fourth year to adjust the odd six hours; so to subtract a day in 134 years, to adjust the deficient Minutes.

As for other nicer Observations in the course of the Sun, as the variations of his *Excentricity*, of his *Apogæum*, of his *Declination*, &c. which have very long Periods; Astronomers may be consulted by those that are Curious, since those Motions are not our Measures of Time.

Having therefore touched (so far as we are concerned) upon some

Phænomena of the Motions of the Sun; we proceed now to those of the Moon.

C H A P. VI.

Of the Lunar Month, and Motion of the Moon; her Quarters, and years. § E-pacts explained. § The Golden Number. § Their Uses (with Tables) and particularly in relation to the first Column of the Calendar in the Common-prayer-book: Several Difficulties about it resolved. § Imperfections and Intricacies in these Accounts.

THE Moon has two Accounts of her Circuit, which are her Months, or as her Years of Revolution. One, her *Periodic* month, or Month of *Peragratiō*, which chiefly respects her own proper Motion, or place in the Zodiac; by which she (like the

Sun in his Year) performs her Revolution round the Zodiac , from any one Point of it, to the same again. And this is made in 27^{D} , 74^{H} , $43'$.

The other is her *Synodic* month, or Month of *Consecution*, and has relation to the Sun, and Earth more particularly in respect of her *Phases*, or various Shapes, and of her *Aspects* to the Sun : and therefore this Month of hers is chiefly, or almost only, consider'd; in regard that the Sun is the chief Regulator of Time, and of the Moon's appearances to our Sight.

This is her Circuit from one Conjunction with the Sun (which we call New-moon, Change, Prime,) to another Conjunction with the same; and because, when she passeth from her Conjunction, by what time she shall have accomplish'd her Month of Peragrations, in the same Space of time, the Sun will be advanced almost a Sign of the Zodiac (which is

30 Degrees) viz. about 27 Degrees: Therefore she must overtake the Sun before she can be in Conjunction with him, which requires about two days; the Sun also, in that time, getting forwards about two Degrees more.

This Month consists of 29 days and a half, Middle-motion; in which her relation to the Sun and Earth is observed; viz. New-moon, or Conjunction; First-quarter, Full-moon, or Opposition; and Last-quarter; and all along her Age, i. e. Number of days, from the last New-moon.

And this is most properly called Month (*Menſis*, from *Mēn*, and Month, from Moon) the other Months, viz. the Days month, of four weeks, or 28 days; and the Years months, of the Sun's passage through one of the 12 Signs, are called Months, only in Allusion to this Lunar-month; and have of themselves no perceptible or visible Periods, but are only gathered, by

uniting a certain number of days, or taking a suitable partition of the year.

We have no visible Monition of the Returns of any other Periods, such as we have of the Day, by Successive Light and Darkness; of the Year, by Succession of the four Seasons; and, lastly, of this Month, by the Variations of the *Phases* of the Moon, and of her Quarters or Seasons, which make a visible Return, and may challenge the Second place, next to the Day, of Signal Evidence to our Observation.

Now, as the Sun goes round his Circle (the Ecliptic) in 12 Months; so, (that the Moon may keep better agreement with the accounts of the Sun) we consider 12 of these Synodic months, to make (as it were) a Year.

But this Year, or Twelve-month, by reason that the Moon's Months are shorter than those of the Sun, (her
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 Month

Month $29\frac{1}{2}$, the Sun's 30, and 31 days) is about 11 days shorter than the Sun's year. The Sun's $365^{\text{D}}, 5^{\text{H}}, 49'$; the Moon's 354^{D} , and about 8 hours. Which number of 11, being the Moon's distance at the year's end, behind the Sun; is necessary to be observed and kept in mind for the whole following year, and the collected account of it for succeeding years, by addition of 11 to it every year successively; if we will reduce the Moon's accounts to those of the Sun's.

And this Number is called the *Epact*, viz. so many days to be added, for an Equation of the Moon to the Sun, in respect of distance.

Supposing the Sun and Moon to be in Conjunction the first day of the year, at the end thereof the Moon's Twelve-month will be finished a 11 days sooner than that of the Sun: So, she will be then, at the end of the Sun's year, 11 days behind him; and the

next year 11 days more, viz. 22; &c.

The Circle of the Epact therefore begins the first year at 11, the next year add 11 to it, and it will be 22; the third year add 11 more, which makes 33; cast out 30, being a whole month, (for the Moon cannot be above a whole Circle before or behind the Sun) and then the Epact is three. And thus proceed, till you shall have gone through all Variations of Epacts, and begin again at 11; still casting away 30, or 29, (for a whole month) as often as it arrives to it, or exceeds it.

All these Variations are finished in 19 years, nearly agreeing with the course of the *Nodes*, i. e. the Points in the Ecliptic, where the Moon crosseth that Circle, as she passeth to her Northern or Southern Latitude; which *Nodes* are called the Head, and Tail, of the Dragon: The Head, when Northward; and the Tail, when to-

wards the South of the Ecliptic. These continually vary, moving in *Antecedentia* about $3'$ *per diem*; which in 19 years make 360 Degrees, or the whole Circle. So, their whole change of place, and Revolution round the Ecliptic, is finished in 19 years, and then begins near the same course again. For which *METON*, of old, in the time of the *Peloponnesian* War, constituted a *Decennoval* Circle, or of 19 years, the same which we now call the Golden-number; and was stiled *Annus*, or *Periodus Metonis*.

The monthly Circuit of the Moon is (as that of the Sun) Oblique to the Equator, and contrary to the Daily motion: But she moves also oblique to the Ecliptic. The Sun keeps constantly in the Ecliptic Circle, in the middle of the Zodiac: But the Moon's Circuit is oblique also to the Ecliptic, crossing it twice in every Synodic month; and proceeding to the

the Latitude of 5 Degrees Northward; and Southward. And, if she happen to be in Conjunction with, or Opposition to the Sun, when she is in either *Node*, crossing the Ecliptic; then there will be an Eclipse: Of the Sun, if in Conjunction; of the Moon, if in Opposition: whence it is called the Ecliptic Line or Circle. It hath been said, that the Moon changeth the *Nodes* or Place of her crossing, at the rate of 3 minutes of a Degree, and somewhat more each day; contrary to the Succession of the 12 Signs; so as to come round in 19 years, and then begin again.

The Moon's Monthly course is not (to us) perfectly round, but in an Oval or Elliptic Figure; sometimes nearer, and sometimes farther from the Earth. She is twice every Month in her *Apogæum*, and twice in her *Perigæum*: the *Apogæum*, near her Conjunction, and Opposition; the *Perigæum*, near

near the two Quarters. Hence is caused an Inequality in her motion.

The Cycle of 19 years goes through all the Variations of the Epacts, as was said; and as it begins with 11, so after every Period of 19 years, it begins at 11 again. And because the Moon, in that space, numbreth seven months more than the Sun, by reason of her Deficiency of 11 days in every Solar year; Seven Months are retrenched in this whole *Decennovary* Progress of the Epacts, to reduce the Accounts of her Motion and Place to those of the Sun: viz. 30 (as that Number, or above it, accrues) is cast away six times; and 29 once, viz. between the last year of one Cycle, and the first of the next ensuing. As in 1690, the Cycle of the Epacts ended with 29: Add 11, it gives 40 for the Epact of the next year, viz. 1691; from 40 you must cast away but 29, and then the Epact remain-

ing

ing is 11. But onwards, to the end of the Cycle, 30 is to be cast away as often as that Number ariseth, or a greater.

Thus the Cycle of *Epacts* serves at all times to shew the Habitude of the Moon to the Sun; *i. e.* her Distance from him.

But because the *Epacts* seem to lie in a confused order of Numbers, making their Progression by 11 every year, and so often casting out 30: therefore a Numeral Account set in order against the *Epacts*, from 1, till it comes to 19; where each Number answers to, and designs its respective *Epact*, being applied to it, makes a perpetual Cycle of 19; which for its excellent use, and because it was set in the Calendar in Golden Letters, is called the *Golden Number*, or *Prime*.

Thus the first of the *Epacts*, 11, has 1, set against it; for the first of the *Golden Number*; the next, *viz.* 22, has 2; the next 33, has 3; the fourth,

viz.

viz. 14, has 4; &c. as in the first of the two Tables following.

<i>Anno Dom.</i>	<i>Epacts</i>	<i>Golden Numb.</i>
1691	11	1
92	22	2
93	33	3
94	14	4
95	25	5
96	36	6
97	17	7
98	28	8
99	39	9
1700	20	10
1	31	11
2	12	12
3	23	13
4	34	14
5	15	15
6	26	16
7	37	17
8	18	18
9	29	19
1710	11	1
11	22	2
12	33	3
13	14	4
14	25	5
&c.	&c.	&c.

<i>Anno Dom.</i>	<i>Epact, as in the Month of July, answering the Golden Numbers; (and Days of the Month) as they stand in the Calendar.</i>	<i>Epacts</i>	<i>Golden Numb.</i>	<i>Month July.</i>
1709		29	19	D.1
1698		28	8	2
		27		+3
1706		26	16	4
1695		25	5	5
		24		+6
1703		23	13	7
1692		22	2	8
		21		+9
1700		20	10	10
		19		+11
1708		18	18	12
1697		17	7	13
		16		+14
1705		15	15	15
1694		14	4	16
		13		+17
1702		12	12	18
1691		11	1	19
		10		+20
1699		9	9	21
		8		22
1707		7	17	+23
1696		6	6	24
		5		+25
1704		4	14	26
1693		3	3	27
		2		+28
1701		1	11	29
				+30
1709		29	19	31

So that, as the Epact is (i. e. the number of days, by which the end of the Moon's 12 Months, at the end of the Solar year, is found to fall short of the Sun's New year:) So is the course of the Moon, or her distance from the Sun, accounted for the whole ensuing year, and for every Nineteenth year after for ever, as was supposed.

And the Golden Number is the *Index*, or *Character* of the Epacts, in a perpetual Cycle; to find which of those 19 years, the present, or any given year is: and consequently, what is then the Epact; and so shews for ever the yearly course of the Moon in relation to the Sun.

The Golden Number being the *Index*, and Cycle of Epacts, the principal use of it is, to find the Epacts; and so they both serve indifferently for the Accounts of the Moon, and furnish you with many usefull Rules
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and Tables for several purposes. As, by the Golden Number, and Dominical Letter given, to find *Easter-day* for ever. Such a Table you have before the Book of Common-Prayer. By the Epact, and Day of the month, is found the Distance at any time, how many days the Moon is from the Sun. It is thus applied to find the Moon's Age ; *i. e.* how many days are past since the last Conjunction ; which shews withall how near she is to her Quarters, Full, or next New-moon ; and is usefull to find her coming to the South, and consequently the Tides, &c.

The Moon's age is thus found , for any given day of any Month. Add to the Epact, the Day of the month, and the *Ordinal* Number of that month from *March* inclusive, (because the Epact begins at *March*) and the Sum of these (casting away 30, or 29, as often as it ariseth) is the Age of the Moon,

Moon. *Ex. gr. Febr. 2. 1691*: to find the Moon's Age, say thus; Epact 11, Day of month 2, Month from *March* 12; Sum of these 25: The Moon is then 25 days old. Again, if it be sought *March 25, 1692*: Epact 22, Day of month 25, Month 1; in all 48; cast away 30, and 18 is the Moon's Age.

The reason why you are so to reckon the Months (from *March*) by addition of an Unite, every succeeding Month, is; because the Moon's year of Twelve Months, being 11 days shorter than that of the Sun; it is in effect a Day for every Month, which is thus accounted for.

You see then, the chief use of the Epacts is (as well as we can) to reconcile the Twelve Months of the Moon to the Sun's year, or Twelve-month; and to measure every single Lunar month all along, by the days of the Solar month; i. e. to make any day of any Solar month so re-

correspond, by help of the Epacts, as to shew the present day of the Month of the Moon, which day, according to the number of it, is called the Age of the Moon: which might have succeeded a little better, if it had pleased the Institutors of the Civil Months of the Sun, to have ordered and placed them alternately odd and even; of 31 and 30 days, beginning (suppose) at *March*, and ending at *February*: And *February* in Common years to have 29 days, and in the Leap-year, 30. But since the old way obtains by Prescription, we must follow it, though with some inconveniency.

The foregoing Rule, to find the Age of the Moon at all times, on any day of any Solar month, cannot shew precisely an exact account of the Moon, because of the Inequality of the Motions of the Sun, and of the Moon, and of the Number of days of the Solar months; though the last of these

these is somewhat helped by observing the old Rule, *Impar Luna pari, Par fiat in Impare Mense*; i. e. by casting out, for a whole Month of the Moon (when there is occasion) 29, in Solar months of 30 days; and 30, when the Month consists of 31 days. I say, though the aforesaid Rule is not exact, yet it comes so near, that it is very fit and necessary for common use; being always at hand, or in memory.

If the Lunations be observed, and set down for a whole course of the Golden Number, or Cycle of 19 years, which is the Cycle of the Moon; the same Observations will serve, and be verified, through the next Cycle of 19 years, in the same order; and so on for succeeding Cycles, (as hath been supposed) for ever.

And therefore the Golden Number, in the first Column of the Calendar, before the Book of Common-Prayer,

is, as a Rule for ever, set before the Day of each Month, in which the Change or Conjunction of the Moon shall happen; whensoever such is the Golden Number, as is there set down. As, if you look, *ex. gr.* upon the Month of *July*, you will see 19 before, or against the first day, 8 before the second, 16 before the fourth, 5 before the fifth, &c. That is, whensoever the Golden Number is 19, there will be New-moon on the first day of *July*; when 8, on the second; if 16, on the fourth; if 5, then on the fifth day; &c.

And though, in the aforesaid Column, the Numbers which denote the Golden Number, seem to stand confusedly, without any order; 19, 8, (and after a space between) 16, 5; yet they precisely follow the Progressive order of the Epacts, of which they are but *Indices*; beginning at the greatest Epact, *viz.* 29, and so descend.

scending in order till they come to the least, viz. 1 : as you may see in the two middle Columns of the second Table preceding ; where the Golden Numbers, 19, 8, 16, 5, 13, 2, 10, &c. are *Indices* of the Epacts in order, viz. 29, 28, 26, 25, 23, 22, 20, &c.

And the reason why they fall in that order in the Calendar, from the greatest Epacts progressively to the least, is ; because the greatest Epacts denote a greater distance of the Moon behind the Sun, and consequently a more Remote approach to her Conjunction. Therefore the *Indices* of these Epacts are set earlier in the Calendar of the Sun's Month, to keep some accord, (as the Sun's longer and Uneven Months will permit) between the Moon's Month, and that of the Sun. And, for the same reason, as the Epacts decrease, so they fall later in the Calendar month. If you find one, or two, or more of the

less *Epacts* set in the beginning; and one, or two, or more greater at the end of the Calendar-month: it happens through the Inequality of the Moon's and Sun's Months. *vide p. 113*

If you ask, Why there are void Spaces in that first Column of the Calendar, some days of the Month having no Golden Numbers set against them? You must remember and consider, that there are no more Varieties of *Epacts* than 19, so measured by the Golden Number, and they arise out of their Annual Progression by 11, till you go through all Variations, and begin again at 11; which is done in 19 Progressions, or 19 years, as you may see in the first Table.

So that they are but enough to set against 19 days of 29, in the Calendar; and 10 of the days having no *Epact*, can have no Golden Number against them.

Take an instance of the Month of

July, in the second Table ; the Days whereof are set Laterally after and against the Columns of Golden Number, and of *Epacts*, and of the correspondent years of our Lord, within one Cycle.

Now , there are no *Epacts* in the aforesaid Progression by 11 , which happen to fall on any of these ten Numbers following ; viz. 27, 24, 21, 19, 16, 13, 10, 8, 5, 2. So that those Days of that Month, where those Numbers should in order fall, because they have no *Epact* , can have no Golden Number set before them : and therefore that Space is left void , viz. as to this Month of *July*, the 3^d, 6, 9, 11, 14, 17, 20, 22, 25, 28th days, (and 30th of the next Cycle.) By which you may plainly see the reason of those void Spaces in this, or any other Month, of the Ecclesiastical Calendar.

It was said before , that the Rule to find the Moon's Age , is not *Pre-*
cise ;

cise ; and the reason is, partly because of the Inequality of her Motion, sometimes swifter, sometimes slower : and partly because of the Sun's unequal Motion ; and partly because of the odd measure of the Solar year, spoken of before. So that I may say, No General Rule, in these Cases, without Limitations, and Equations, can be exact. I will insist only on the last Incumbrance ; *viz.* the odd measure of the Solar year ; I mean the odd, or Supernumerary, 6 hours ; which are not accounted in the three years after the Leap-year, which (as I said) consists of no more than 365 days, without the odd six hours.

Suppose you apply this Rule to find the Moon's Age, and suppose it exactly true (which indeed it is not) for any Day, or Month, in a year that is the first year after *Bissextile* ; you will find it not agree exactly to the succeeding three years.

For the second year after *Bissextile*, takes his beginning six hours before the end of the foregoing year be fulfilled: Therefore the Computations of the Motions and Places of the Sun and Moon will be six hours earlier all that year, than they will be pointed at by the Rule: And, for the same reason, in the next year, *viz.* the third after Leap-year, the Sun and Moon's places will be computed twelve hours sooner; and in the Leap-year; for the former two Months, *viz.* till after the *Interellar* day, 18 hours sooner; and in the remainder of that year, six hours later.

You see how considerable it is, in which of these four years, you make use of Rules, or Tables, for the Heavenly motions; because there may be near 6, or 12, or 18 hours difference in the true Age of the Moon, from the time assigned by the Rule. And the like happens to the computation

of

of the Sun's entrance into the four Cardinal Signs, and of his whole yearly Progress in the Leap-year, and the three years after it respectively; and so likewise of the other Planets.

C H A P. VII.

An Important defect in Ecclesiastical Computations by the Nicene Rule, arising from hence; that the Golden Number does not exactly measure the Moon's Cycle. § The Sun's Account above ten days too late, and the Moon's above four; and needs Rectification.

BUT besides these Astronomical Intricacies of Calculation, which I have transiently mentioned; there remains one most considerable, Important Defect, in Ecclesiastical Computations after the Nicene Rule, in relation to the Moon,

For the Golden Number does not so exactly comply with and measure the Moon's Cycle, but that there is found an *Anomaly*, (like that of the Sun's *Anticipation* of $10'. 44''$.) For though the Moon in 19 years seems to renew her same course respective to the Sun, yet it is found, she falls short in that time almost an hour and half, which in 16 *Decennoval* Cycles amount to 24 hours, or a Natural Day; viz. 16 hours, and 16 half hours: And thus, 16 Cycles are compleated in 304 years, or rather, as some more accurately seem to calculate, in 312 years; making the *Anticipation* of the Moon, at the end of every Cycle, to be somewhat less, viz. $1^h, 27', 32'', 42'''$.

Now, as the *Nicene* Council fixed the Equinox, upon the 21 of *March*, for the finding out of *Easter*, which has caused the Misguidance from the Sun, which we lie under, in respect of

of *Easter*, and the moveable Feasts : so the same Council likewise fixed the Accounts of the Moon , upon the Cycle of the Golden Number, as it then pointed out the Lunations , and therefore placed it in the Calendar, for a perpetual Rule (as is said before.)

But now we find (for the reasons before assigned) that the Golden Number, so fixed, gives us the New-moon's, and Full, and other Accounts of the Moon, more than four days too late ; by reason of the aforesaid *Anticipation*, and our neglect of it : Which also wants Reformation , like that which is attempted in the *Gregorian Calendar*.

For , at this time , the Sun's Account, by our old *Julian year*, is above ten Days too late : and that of the Moon above four Days. When therefore the Accounts of the Moon are also rectified and reformed , and the Golden Numbers once rightly applied

plied to the Days of the Months ; they may be kept so, for many Ages, and kept right ; by allowing one Day at every end of 312 years, for an Equation of the Moon's Cycle.

The Council of Nice was celebrated *Anno Domini* 325 ; since which there have passed four times 312 years, to the year 1573 : which then caused an Error of four Days, and was reformed soon after, viz. 1582. From thence, viz. 1573, to this present year 1693, there have passed 120 years ; which contain six Cycles of the Moon, and six years Currant, which cause a farther *Anticipation* of almost nine hours. So much the Rule, by the Golden Number, assigns the *Aspects* of the Moon to the Sun later, than by true account they are found to be.

Therefore, in the aforesaid first Column, in the Calendar before our Book of Common-Prayer, in any of
the

the Months, having found out, amongst those Figures of that Column, the Golden Number for the present year ; instead of the Day of the Month over against it, reckon four Days and nine Hours before it, and you have the Day of the Moon for Common use : or, which amounts to the same, reckon that Day of the Month which has the Golden Number belonging to it (over against it) for the fifth Day of the Moon's Age.

Thus much hath been said of the Accounts of the Sun and Moon, principally for the better understanding of our Calendar ; which being constituted after the old *Julian* year, we may see what need there is of Rectifying it from those *Anomalies*, which in this long tract of time, since the *Nicene* Council, have crept into it ; tending to the displacing of the Seasons of the year, and misplacing the Festivals of the Church : And to shew also

also the Grounds and Reasons of the Cycle of the Moon's *Epacts*, viz. the Golden Number; which so often occurs to us, and of which we may make so frequent and continual use.

C H A P. VIII.

*Conclusion ; containing some short Observations , and Practical Deductions .
 & With a brief Account of the Author's New Hypothesis , concerning the Natural Production and Differences of the Letters of the Alphabet ; relating to a Treatise formerly Published by him , Of the Elements of Speech : Of which the Contents also are annexed .*

FROM what hath been said, the Reader may (amongst other things) observe the Agreements, and Differences of the Measures of Time,

to, and from those other Material Permanent Measures of Distance, and Capacity, and Weight, first spoken of.

And that, of the Measures of Time, some are Natural and Universal; and some Arbitrary and Artificial, and confined diversly to several Nations.

The *Noctidial* Day, the Lunar *Periodic* Month, and the Solar Year are Natural and Universal; but Incommensurate each to other, and difficult to be reconciled: Yet we are constrained to make use of them, as Measures to one another, reducing the Disagreements; by Observing, and Collecting, and allowing for their Differences.

Other Measures, as Hour, Week, Month of Weeks, Solar Calendar Months, are more Artificial and Arbitrary, for the use of Common Life; and serve for Measures, by Public Sanction, Consent, and Usage of so many Nations as are agreed to them, and

and so are made very usefull, by which to measure the other. The former also, though Natural and Universal, yet are subject to the like Regulations.

If we measure the Year by Days, there will be found a Remainder at last of about six Hours above 365 Days; Whence *Julius Caesar* ordained, that in the Account of Years, the odd 6 Hours should be omitted in the First, and a Second, and a Third Year, and collected every Fourth Year; adding the *Bissextile* day to that year. So you see we follow a Calendar not exactly true in Nature, nor Equal, but Artificially contrived for common Use, by the *Julian* Institution.

And the Calendar Months are likewise Arbitrarily, and Unequally settled by the same Power; by which Months we to this day Account, and they measure, and make up that which we call the *Julian* year.

Now take a short Review of some Measures relating to the Calendar, which have been more largely treated in the foregoing Discourse.

Measure the Year by Days; and the remaining odd Part of a Day, which *κατὰ πλάττω*, or *Numero rotundo*, is accounted six hours, shews the Reason of the *Bissextile*, or Leap-year.

Again, Measure the Year by Weeks; and the remaining odd Day, for three Years successively, and two odd Days in the fourth, or Leap-year, shew the Reason of the yearly Change of the *Dominical Letter*, and the Nature and Use of the Cycle of the Sun, which is 28.

Again, Measure the Year by Lunar Synodic Months; and the remaining 11 days, by which 12 Lunar months fall short of the Solar year, make the *Epacts*, and shew the Reason of their Observation and Use.

Again.

Again, Pursue, and Observe all the Variations of *Epacts*, till they return to the same again; and you will find that Revolution to be made at the end of every Nineteenth year: which Number of Nineteen constitutes the Cycle of the Moon, viz. the *Golden Number*. And thus proceeds our *Julian year*.

But then, Consider more narrowly; that the odd Hours at the end of the Solar Year, are not indeed fully six, but are deficient 10', 44"; which Deficiency in 134 years (collected) amounts to a whole Day. And hence may be seen the Reason, why the *Vernal Equinox*, which at the time of the *Nicene Council* fell upon the 21st of *March*, falls now above 10 days sooner, viz. about the 10th of *March*: which was one Reason of the *Gregorian Reformation of the Calendar*.

Again, Consider, that the Golden Number does not perfectly correspond with so many Revolutions of the Moon, as are made in that time; but the Period of those Revolutions is accomplished in somewhat less space than full 19 years; viz. near an hour and half sooner: which sets her back so much in every Cycle; and, collected, amounts to a whole day in about 312 years; which is called the ~~excess~~ *or Anticipation* of the Moon. So that, following the Accounts of the Moon, as directed by that perpetual Cycle of the Moon, called the Golden Number, placed for that purpose at the Nicene Council, before, and along the Ecclesiastic Calendar, and continued still in ours; we now find above four days difference; viz. so much later than the true Account, which was another Reason of the Reformation of the Calendar.

Remember lastly, what has been observed before, (to shew the power of *Legislative* Authority, and Consent, and Practice, in ordering and using Measures.) That the Measure of the Year by Solar months, as constituted by *Julius Caesar*, and a little altered by *Augustus*, his Successor; tho' it be Irregular, Imperfect, Unequal, and wholly Artificial, having little agreement with the Natural Measures of Time: Yet because it is made to consist of *Integer* days, and consequently more easie and Certain to be applied; viz. Days to Months, and Months to Years: is become, by the help of Authentic Calendars, one of the Principal Measures of Time for Common use; especially when joined with the other.

We measure the Beginning, and Progress, and End of the Year, by these Months, and the Days of which they consist; we Date all Affairs, A-

a Dumb Person, then with him in his house; which obliged, and urged him to more Sedulity in bending his Thoughts upon it, such as are since published, *Anno 1669*, in a Treatise *Of the Elements of Speech*: He thinks he may, without Vanity, because not without sufficient Provocation, Commend, and Submit to the Readers impartial judgment, a certain new *Hypothesis* of the Natural Production, and Differences of the *Letters* of the *Alphabet*: Reducing all different *Articulations* of *Consonants* (to instance in them) made by the *Organs* of Speech, to the Number of Nine, and Supplying the Essential Differences of the remaining Number of those *Letters*, by finding out 4 sufficient Discriminations of *Letters*, from their *Material Part*, *i. e.* *Sound*, which is *Articulated*; there being four Differences of *Sound* which go to the making of *Letters*: *viz.* *Breath Oral*, (as in *Whispering*) *Voice Oral*, *Breath*

Ore-Nasal, and *Voice Ore-Nasal*. Thus P, B, M, and a *Spiritual M*, (which is not in use) are distinguished by those Differences of *Sound*, though they all have the same, and but one *Articulation* by the *Organs* of Speech. Like as we may, with one *Seal*, Impressed upon Wax of four several Colours, (suppose Yellow, and Green, and Red, and Black) make four as different *Signs*, as from four different *Seals* upon the same Coloured Wax.

Thus, Every single *Articulation*, Impressed upon those four distinct *Matters* of *Sound*, produceth four distinct *Consonant Letters*, which ought to be ranged in every single *Classis* of *Articulation*. Thus to one and the same *Articulation* by the Lips, belong B, P, M, M', and differ only in *Sound*, as hath been said. Now nine *Articulations* Impressed upon four sorts of different *Matter* of *Sound*, make in all thirty six *Consonants*, wherein are comprised all possi-

possible *Consonants* used by any Nation in the World: And they do Orderly, and Equally fill up the *Abacus*, and *Classes* of *Consonants*. Like as nine distinct *Seals*, Impressed upon four sorts of Wax, *viz.* of four several Colours, may serve to make thirty six Sensible Discriminations for *Signs*, to be agreed upon for Mutual Communication. For, the Impression of a Lyon upon Black-wax will differ from that which is made upon Red, as sensibly as a Lyon differs from a Boar, on the same coloured Wax. We may impute the *Formal* Differences to the nine *Seals* which give the Impression, and the Differences *Material*, to the four sorts of Wax which receive them: resembling the 9 *Articulations* in Speech, giving *Form*; and four sorts of *Sound*, being the *Material* Part, which receives the Impressions of the *Articulating* Motions.

Whereas other Writers on this Subject, taking for granted, the Number of *Articulations* to be equal to the Number of *Letters*; each *Letter* having a peculiar distinct *Articulation*; in their Table, or *Abacus* of *Letters*, rank some of those *Letters* in *Ternaries*, some in *Pairs*, and let some stand Single; not giving any Reason for the void Spaces in the *Abacus*, nor for the Order in which they are placed: Except, as to the latter, by referring to the Parts of the Mouth, where the *Articulations* are formed; beginning, ex. gr. at the *Labial Letters*, of which they find three, and suppose them to be framed by three several *Articulations* by the Lips; whereas there is indeed but one *Articulation*, which differenceth the *Labial Letters* from those made by other *Organs*; but between themselves, these three are differenced by the *Matter of Sound Articulated*.

Then, rejecting, and laying aside such *Letters* of those thirty six, as are not Gracefull, nor Easie to be pronounced, having enough besides : Seventeen *Consonants* are cast off, for reasons there assigned, and marked in the *Abacus* with an *Obelisk*; and 19 are retained for the use of Speech. And it is no wonder, if they who considered but 19, or about that number, could not tell how to Rank them in Equal *Classes*; whereas, in the *Author's Abacus*, or Table of *Letters*, the whole number of *Consonants*, viz. 36, will be found Equally ranged, with their proper Differences, and Productions : 19 of them being owned for the use of Speech, and the remaining 17 noted with a Mark of Rejection. For which the Reader is referred to the aforesaid *Treatise*.

Which *Treatise* lying not so plain for want of an *Index*; here is annexed a short View of the *Contents* of it.

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Copies of these *Contents* are Printed,
and put into Mr. *Luke Meredith's*
hand, to be delivered *gratis* to
any Possessor of the said *Treatise*,
Gentleman, or Bookseller, to be
prefixed to the Book.

Addendum,

Addendum, as an *Appendix* to the
 Paragraph ending [—after the
 Moon and Sun's Month.]
 pag. 88. line 5.

It is here needfull to be better explained, how the Moon is said to be *Behind*, and how *Before*, the Sun; both which, or either of them, it may be understood to be.

The Moon goes round her Circuit above 12 times, whilst the Sun passeth once about his; And so many times overtakes; and also goes beyond the Sun. In every time, to keep her habitude to the Sun, she goes more than a Round, having the whole Zodiac, and about one of the 12 Signs more, to pass after her Conjunction, before she overtakes the Sun again. And if she may be said to overtake the Sun; she may not improperly be said to be *behind* him, untill she overtake

take him. If we look back upon the last pass'd Conjunction; Then the Moon was joyned with the Sun, and moving swifter, is now got *before* him: If upon the next approaching Conjunction; Then the Moon is drawing towards him, and is *behind* him.

Thus, when the Epact is 1; the Moon, at the end of the year, will be 11 days in her progress, beyond or before the Sun, having got so far since the last Conjunction: But in respect of the next ensuing Conjunction, to which her Motion tends; she will be found about 19 days *behind* the Sun. Thus she is both *before*, and *behind* the Sun, 12 (or in some years 13) times in a year.

But since the *Epact* is properly the Number of Days, by which the Moon has finished her 12 Months sooner than the Sun his; or, (which amounts to the same) the Number of Days of the Age of the Moon, viz. which have passed

passed between her last Conjunction, and the Close of the Sun's year, tho' in the Remainder or Complement of Days which respect her next ensuing Conjunction, she be *behind* the Sun : yet, in the former Respect, she must be said to be *before* him. And therefore it may be less exceptionable to Consider her, as *before* the Sun, and Correct those Passages which seem to look otherwise.

To explain this more clearly ; If two run a Race, he that comes first to the Post, is properly said to be *before* the other : So the Moon beginning her 12 Months with the Sun, and arriving at the End of them 11 days before the Sun, is properly said to be so much *before* him. And Consequently (both of them continuing their Course of Revolutions) she keeps on, throughout the whole ensuing year, 11 days before the Sun in her *Synodic Chase*, besides her gaining, more.

I 2

over,

over, about a Day in every Solar Month; *i. e.* 11 days in 12 Solar Months. Therefore, as was said, *p. 82.* to accommodate the Course of the Month of the Moon, to that of the Sun, we add all along, to the day of the Solar month, the Number of those days in the foregoing year, between the latest Conjunction of the Moon, and the End of the Sun's year, which are therefore called *Epacts*; together with the Number of Months from *March*.

We might more properly reckon by the Day of the Moon's Month, as we do by that of the Sun; but then *The Day of the Month* would be an ambiguous term, relating as well to the Moon, as to the Sun. Therefore it is usually termed *The Age of the Moon*, which is the same with the *Day of her Month*, but wholly avoids the ambiguity.

Now the *Epacts* varying every Year by progression of 11; It is so, that the Greater the *Epact*, (i. e. the Age of the Moon, at the End of the Sun's year,) happens to be; so much Shorter will be the Remainder, or Complement of days to the next Conjunction: which shews the Reason of the Order of *Epacts*, pointed at by the Golden Number, in the first Column of the Church Calendar.

I take the Month of *July* there, in which to make Instance, because it begins with the greatest *Epact* 29, pointed at by the Golden Number 19: The Reader will find those Columns in the said Calendar very carelessly Printed; but they may be easily corrected by the Table foregoing, observing the order of those Numbers.

When the *Epact* is 29 and Golden Number 19, as it was 1690, and will be 1709: The true Complement to the next New-moon will be

but half a Day. So the Moon will be in her Change (not truly, but according to that Rule by the Golden Number) the First of *July*; and that will be the first day both of the Sun's, and of the Moon's Month, and you may reckon the Age of the Moon, by the Day of the Month, throughout that one Lunation. Otherwise the Moon's Age must be reconciled to the Day of the Month, by the Epacts, and Number of Months from *March*. The Solar month being made the Standard, to which other Measures are reduced.

When the Moon Changeth (according to the same account) on the second day of *July*, as *Anno Dom.* 1698, the Epact will be 28, Golden Number 8, and the Second of *July* will be the First of the Moon. When on the Fourth of *July*, as *Anno Domini* 1687, 1706. Then the Epact is 26, and Golden Number 16; and the Fourth

of *July*, the First of the Moon. And thus still the Epacts decrease in order, as the Days of the month go forward. Now this shews plainly the Reason of the Regular progressive Order (by Decrease) of the Epacts; and of the seeming Disorder of the Golden Number in that Calendar, throughout the Month of *July*: And in the same manner in all other Months; always allowing for the Differences in the Places of those Numbers, which will arise from the Inequality of the Solar and Lunar months. From whence it is, That in the Year 1709, Epact 29, the Moon's Change will be allotted to *Apr. 4. May 3. June 2. July 1, and 31. August 29. September 27, &c.*

If you ask, Why, &c. p. 88.

F I N I S.

C O R R I G E N D A

Pag. 73. lin. 7. *before or beyond the Sun.*
lin. ult. *11. days before film.*

Pag. 87. l. 13, 14. *of the Moon before the
Sun, and consequently a nearer approach.*

Pag. 88. l. 20. *against 19 Days of 29, or
30, in the Calendar.*

l. 23. *against them, and sometimes
an Eleventh day, viz. the Space between
the end of one Cycle, and beginning of
another.*

Pag. 95. l. 3. *for Abowing; r. Abbridging.*

P R I N T E D